Fuzzy Spark Advance Scheduling For Internal Combustion Engine

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The authors have considered engine timing model which describes a simulation of a four-cylinder spark ignition internal combustion engine [1]. A new approach for dynamic control of spark advance using fuzzy logic based scheduler has been proposed. By introducing variable spark advance value, the set-point remains in the area of maximum torque developed by the engine.

The key elements of the engine model are: throttle, intake manifold, mass flow rate, intake to power stroke delay, torque function and engine speed. An internal combustion engine from the throttle to the crankshaft output can be modelled using *Matlab/Simulink*. Time based model is converted to a crank angle synchronized model by using a *Hit Crossing Block* which captures accurately discrete events such as the beginning of the intake stroke for each cylinder.

Fuzzy logic based controller has been introduced for the purpose of spark advance scheduling. Fuzzy controller is fired only once every 180 degrees using discrete blocks with sample time set to 1. Based on engine speed and mass of fuel-air mixture cylinder for combustion as fuzzy scheduler inputs, input normalization for their crisp values is performed. Using rule-term base, fuzzy logic rules and fuzzy inference procedure, spark advance fuzzy value can be determined. Fuzzy output value is then denormalized using centre of gravity method.

Considering that engine gain is variable (dynamical properties of the engine are not stationary) parameters of the PID controller in the control loop must be modified. The gain is dynamically normalized with the knowledge of spark advance value.

References

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[3] C. C. Lee, "Fuzzy logic in control systems: fuzzy logic controller, part I, II", IEEE, Trans. Syst. Man Cybern., Vol. 20, pp. 404-435, 1990.

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